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FLOOD INSURANCE STUDY

ORIGINAL

CITY OF EVERETT, MASSACHUSETTS
MIDDLESEX COUNTY

JUNE 3, 1986

Federal Emergency Management Agency

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FLOOD INSURANCE STUDY
CITY OF EVERETT, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Everett, Middlesex County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Camp Dresser and McKee Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-84-C-1601. This work was completed in January 1985.

1.3 Coordination

In April 1984, streams requiring detailed study were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of FEMA, the City of Everett, and Camp Dresser and McKee Inc. (the study contractor). Results of the hydrologic analyses were coordinated with the U. S. Geological Survey (USGS), the U. S. Army Corps of Engineers (COE), and the Metropolitan District Commission (MDC). On July 11, 1985, the results of the study were reviewed at a final CCO meeting held with representatives of FEMA, the city, and the study contractor.

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2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Everett, Middlesex County, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding from the Atlantic Ocean affecting the Mystic River and the Island End River was studied by detailed methods. Flooding from the Malden River was also studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through January 1990.

An unnamed stream in the northern portion of the city was studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Everett.

2.2 Community Description

The City of Everett is located in the southeastern portion of Middlesex County in eastern Massachusetts, approximately 2 miles north of the City of Boston. It is bordered by the City of Malden to the north, the City of Medford to the west, the Cities of Somerville and Boston to the south, and the Cities of Chelsea and Revere to the east. According to the U. S. Bureau of the Census, the population of Everett decreased from 42,485 in 1979 to 37,195 in 1980, a 12.5-percent decrease (Reference 1). The total land area contained within the Everett corporate limits is 3.7 square miles.

The Mystic River flows along the southern corporate limits of the city. The part of the river downstream of Amelia Earhart Dam is tidal in nature, actually being an extension of Boston Inner Harbor.

The Malden River, a tributary of the Mystic River, originates at Spot Pond in the Town of Stoneham. It flows south, forming the boundary between Medford and Everett, and discharges into the Mystic River just upstream of Amelia Earhart Dam. Its drainage area encompasses 11.4 square miles. The total drainage area of the Mystic and Malden Rivers above Amelia Earhart Dam is 61.9 square miles.

The Island End River is a small tidally influenced tributary of the Mystic River that forms part of the southeastern corporate limits of Everett. It extends approximately 0.5 mile northeast from its confluence with the Mystic River, downstream of Amelia Earhart Dam.

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FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF EVERETT, MA

(MIDDLESEX CO.)

APPROXIMATE SCALE

0 4000 8000 12000 FEET

VICINITY MAP

Everett is completely developed. Within the flood plains studied, development is primarily commercial-industrial, with a small portion consisting of multi-family residences.

The climate of Everett is typical of eastern Massachusetts. Temperature averages range from 72.7 degrees Fahrenheit (°F) in summer to 28.7°F in winter. The average annual precipitation is 41.4 inches; the average recorded snowfall is 42 inches. The precipitation is fairly evenly distributed throughout the year (Reference 2).

2.3 Principal Flood Problems

Flooding along the coastline of Everett (downstream of Amelia Earhart Dam) is greatly influenced by storm surge elevations from Boston Harbor. The flood of record occurred in February 1978, although no serious damage was reported. A flood elevation of 10.25 feet was recorded at the U.S.S. Constitution in the nearby Charlestown section of Boston (Reference 3).

A number of major floods have occurred in the Mystic River basin above Amelia Earhart Dam during the twentieth century, the worst of which were in 1936, 1955, 1968, 1978, and 1979.

Flooding on the Malden River can occur during any season of the year; however, most major floods have occurred during February, March, and April and are usually the result of spring rains and/or snowmelt. Floods occurring during the midsummer and late summer are often associated with tropical storms moving up the Atlantic coastline.

2.4 Flood Protection Measures

Amelia Earhart Dam is located at the confluence of the Mystic and Malden Rivers. Constructed by the MDC and the COE between 1967 and 1976, it is a multi-purpose structure under the jurisdiction of the MDC. The dam, which eliminated the tidal influence upstream, can pump 4,000 cubic feet per second of flow from the Mystic and Malden Rivers against high tide into Boston Harbor.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2,

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1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish inflow storm hydrographs and peak elevation-frequency relationships for the flooding sources studied in detail affecting the community.

The Mystic River Comprehensive Hydrology Study was performed to determine the flood potential upstream of Amelia Earhart Dam (Reference 4). This Flood Insurance Study uses the techniques and results obtained from the hydrology study.

The hydrologic technique used above Amelia Earhart Dam was a computer simulation of the rainfall-runoff processes as they affect the land within the entire basin. Rainfall events were simulated using the M.I.T. Catchment (MITCAT) rainfall-runoff model (Reference 5). Storm hydrographs from the rainfall events were generated and later used as input to the hydraulic model of the Mystic River system.

Due to both Amelia Earhart Dam and the large amounts of storage found along the streams, the Mystic-Malden River system acts more like a series of reservoirs than as free flowing streams. Peak stages are not the result of peak discharges and generally do not occur at the time of peak discharge. The relationship between inflows, outflows, and the resultant change in storage dominates the system.

The discharges for Amelia Earhart Dam represent the pumping capacity at the dam during periods of high tide. The discharge through the dam can be greater when tidal conditions are lower than water levels above the dam, in which case water from upstream of the dam is allowed to pass through the lock gates.

A summary of representative peak discharges for the Malden River is shown in Table 1, "Summary of Discharges." As stated earlier, however, peak flood stages are not caused by the peak discharge but by the runoff volume and basin-storage relationship.

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TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
MALDEN RIVER					
Upstream side of Amelia Earhart Dam	61.9	4,000	4,000	4,000	4,000
At the Everett-Malden corporate limits	9.2	853	1,200	1,409	1,893

Storm surge elevations for the Atlantic Ocean affecting the Mystic River and the Island End River were determined by FEMA. The storm surge elevations used in this study were obtained from the Flood Insurance Study for the City of Chelsea (Reference 6).

A summary of peak elevation-frequency relationships for the Atlantic Ocean is shown in Table 2, "Summary of Stillwater Elevations."

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ATLANTIC OCEAN				
Mystic River downstream of Amelia Earhart Dam	9.1	9.9	10.3	11.1
Island End River	9.1	10.0	10.3	11.2

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

No new cross-section data were required for this study, as all information was available in the Mystic River Comprehensive Hydrology Study (Reference 4). Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1).

Water-surface elevations of floods of the selected recurrence intervals were computed using the FLOW2D computer simulation model (Reference 7). The input to the model includes full storm hydrographs from MITCAT,

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storage-elevation relationships for areas along the Mystic and Malden Rivers, hydraulic properties of the streams and control structures, and operating characteristics of Amelia Earhart Dam. Water-surface elevations of simulated floods were computed through the use of the FLOW2D program. The computer model was calibrated using historic floodwater profiles. The output from the model consisted of time histories of flood elevations at various locations for each particular storm selected. The recurrence interval of the peak flood elevations was determined based on a statistical analysis of these results. Elevation versus recurrence interval plots were created. The elevations for the 10-, 50-, 100-, and 500-year recurrence intervals were then determined from the plots. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and flood plain areas. The channel "n" and overbank "n" values for the Mystic River and the Malden River ranged from 0.020 to 0.050.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For the flooding sources studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (References 8 and 9).

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For the stream studied by approximate methods, the boundary of the 100-year flood was delineated using the Flood Hazard Boundary Map for the City of Everett (Reference 10).

The 100- and 500-year flood plain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights.

No floodways were computed for the Mystic and Malden Rivers because the river banks are steep, with portions under tidal influence, and 100-year flood elevations are contained within the stream channels.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the City of Everett.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the Mystic and Malden Rivers are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Atlantic Ocean (Tidal flooding affecting the Mystic River downstream of Amelia Earhart Dam, and the Island End River)							
Reach 1	01	-1.2	-0.4	+0.8	010	A2	10
Malden River							
Reach 1	01	-2.0	-0.7	+2.5	020	A4	4

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF EVERETT, MA
(MIDDLESEX CO.)

FLOOD INSURANCE ZONE DATA

ATLANTIC OCEAN AND MALDEN RIVER

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In tidal areas, reaches are limited to the distance for which the 100-year flood elevation does not vary more than 1.0 foot. Using these criteria, one reach was required for the tidal flooding source of the City of Everett. The location of this reach is shown on the Flood Insurance Rate Map and summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A2 and A4:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

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Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Everett is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies for the Cities of Boston, Chelsea, and Revere have been completed (References 3, 6, and 11). The results of this study will be in exact agreement with the results of the Boston and Revere studies. Flood boundaries between this study and the Chelsea study do not match because of the use of updated base maps in this study.

Flood Insurance Studies for the Cities of Medford, Somerville, and Malden are currently being prepared (References 12, 13, and 14). The results of those studies will be in exact agreement with the results of this study.

Due to a more detailed analysis, this study supersedes the Flood Hazard Boundary Map for Everett (Reference 10).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

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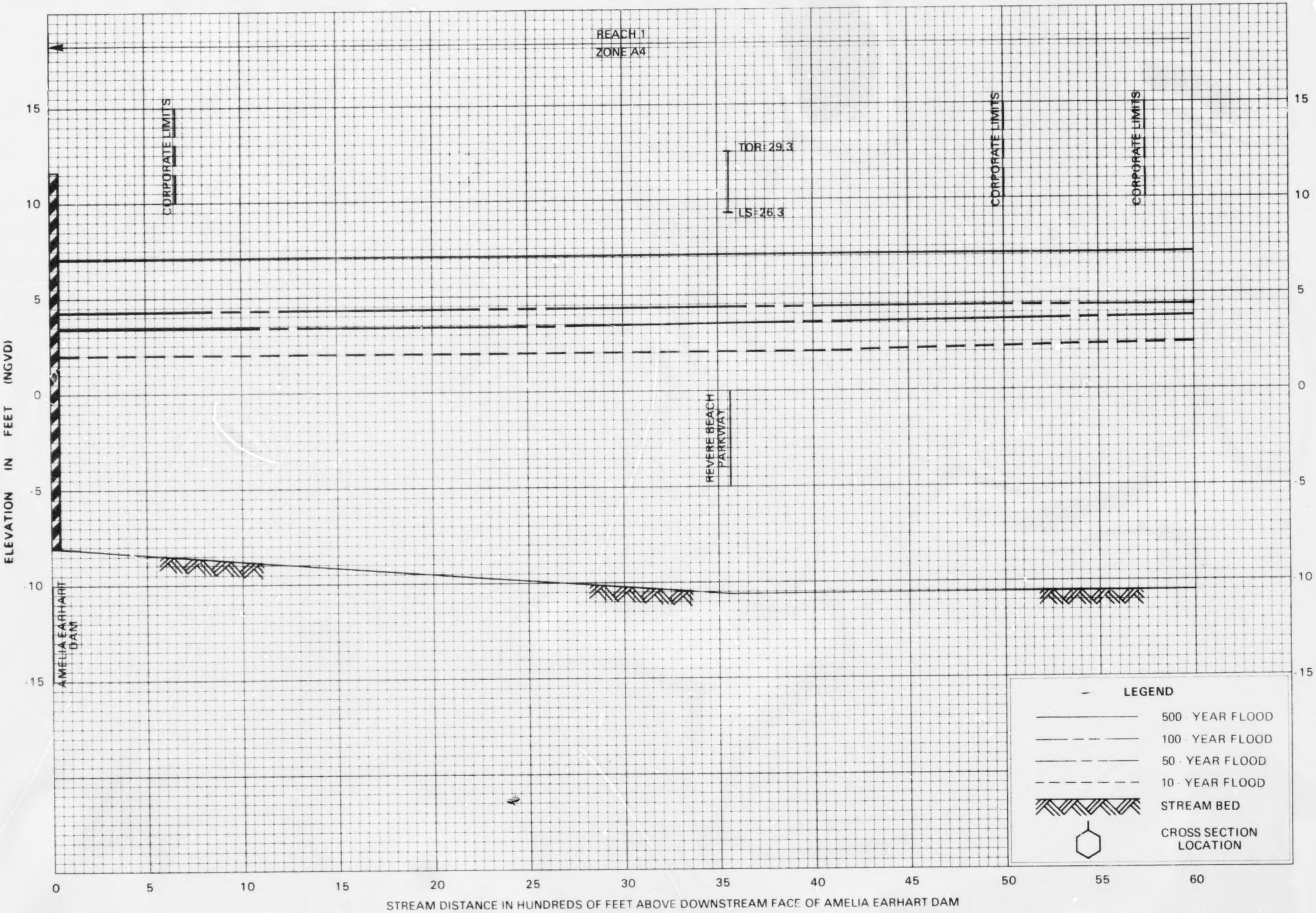

FLOOD PROFILES

MALDEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF EVERETT, MA

(MIDDLESEX CO.)

01P

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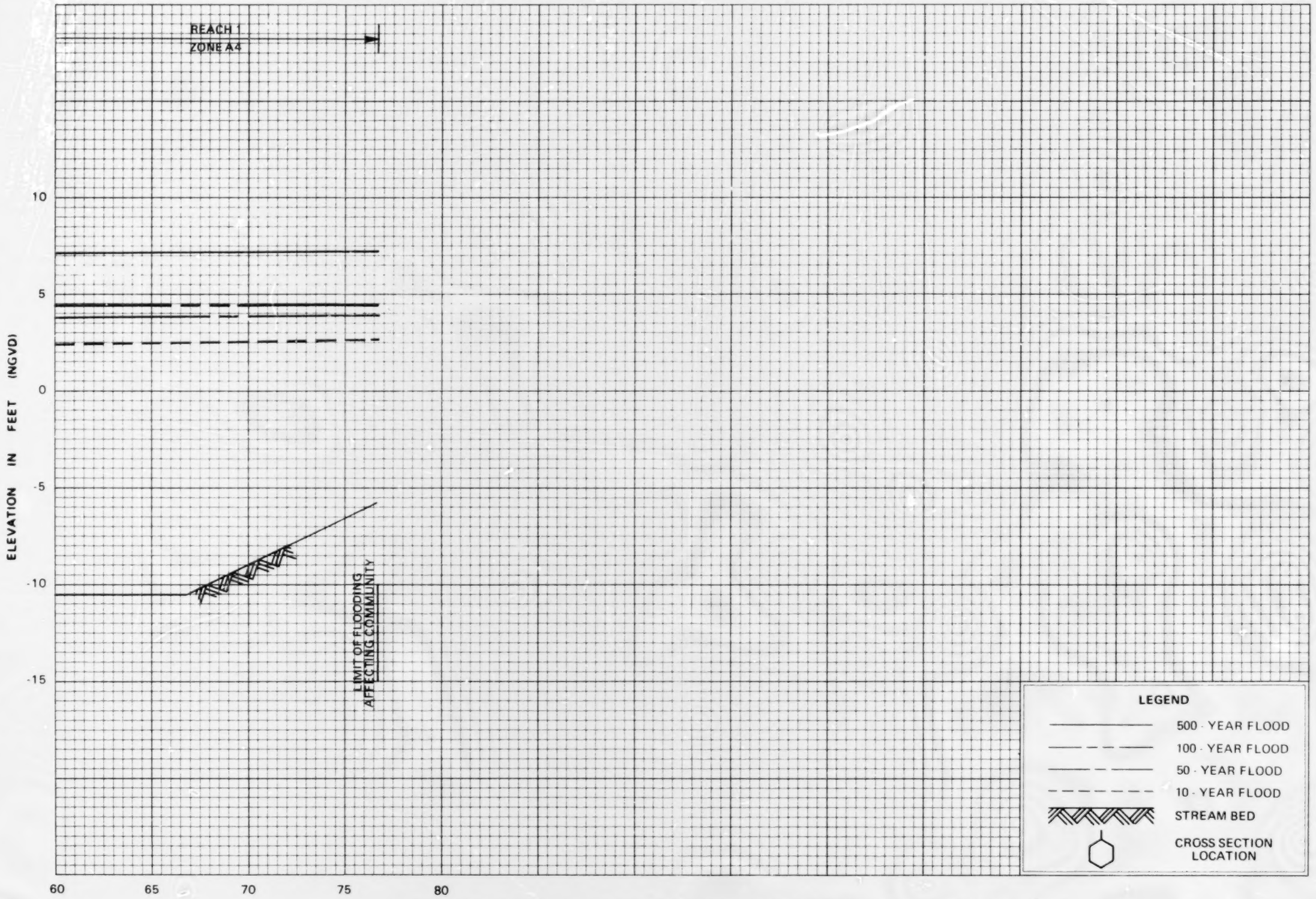

FLOOD PROFILES

MALDEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF EVERETT, MA

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